



CAIT

Center for Advanced Infrastructure & Transportation
Rutgers, The State University of New Jersey

QUARTERLY PROGRESS REPORT

Project Title:	Investigation into Modified Asphalt Binders for Improved Pavement Performance		
RFP NUMBER:	NJDOT RESEARCH PROJECT MANAGER: Mr. Anthony Chmiel		
TASK ORDER NUMBER/Study Number: Task Order No. 80 / 4-23908	PRINCIPAL INVESTIGATOR: Dr. Ali Maher		
Study Start Date: 02/01/2000 Study End Date: 01/31/2003	Period Covered: 2 nd Quarter 2003		

Task	% of Total	% of Task this quarter	% of Task to date	% of Total Complete
Literature Search	10%	50%	100%	10%
1. Material Collection	5%	25%	100%	5%
2. Laboratory Testing	50%	20%	100%	50%
3. Calibration	15%	10%	100%	15%
4. Reporting	20%	10%	95%	19%
Final Report				
TOTAL	100%			99%

1. Progress this quarter by task:

- A. The Simple Shear at Constant Height (SSCH) and Frequency Sweep at Constant Height (FSCH) testing of long term oven-aged samples finished. The SSCH were run at 4, 20, and 40C, and the FSCH were tested at 20, 40, 52C, identical temperatures to the short term oven-aged samples. Results of the SSCH showed that the creep properties at low temperatures stiffened while remaining similar at intermediate and higher temperatures (20 and 40C). Results from the FSCH testing showed a shear modulus (G*) increase when tested at 20C, however, at 52C, the stiffness of the aged samples showed a lower G* than the unaged samples. The G* comparisons at 40C was mixed. Only the two PG76-22 mixes showed to have no significant G* decrease when tested at higher temperatures. Another illustration of the hardening at low temperatures and softening at high temperatures was supported by evaluating the phase angle values. The phase angle is the delay in response due to an applied load. For an elastic material (HMA at cold temperatures) the phase angle approaches zero and for a viscous material (HMA at high temperatures) the phase angle approaches 90 degrees. At low temperatures, the phase angle of the aged samples decreased, indicating that the material was becoming stiffer. However, at higher temperatures, the phase angle of the aged samples was larger than that of the unaged samples, indicating that the material was behaving more viscous or softening. It was originally thought that the conflicting results between the SSCH and the FSCH was due to the different test temperatures. Therefore, to evaluate if the stiffness of the mixes actually did decrease at higher temperatures, Repeated Shear at Constant Height (RSCH) tests were conducted at 64C. The results of the RSCH testing statistically showed little difference between the aged and unaged samples. Therefore, something is effecting the FSCH G* and not the SSCH and RSCH results. To aid in this evaluation, experts in the industry were contacted. Ray Bonaquist from Advanced Asphalt Technologies, John Harvey from the University of California, Berkeley, Rebecca McDaniel from the Northeast Superpave Center, and Terhi Pellinen from Purdue University. The following were comments from each:

Ray Bonaquist – Believed that errors due to FSCH testing at temperatures 52C and above was the main cause. The FSCH requires 0.01% shear strain and at high test temperatures, this does not relate to large applied stresses. Since a certain amount of load is required to move the shear table, the actual

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stress measured from the load cell may just be the required movement load since the asphalt mix is soft at these temperatures.

John Harvey – Believed that the decrease in small strain stiffness may be due to the some type of binder/additive separation during oven aging process. He suggested that there may be change in the phases of the binder/additive at the elevated temperatures at prolonged time periods. Unfortunately, as we further discussed the problem, he also realized that all additives were added to the sample PG64-22 which also exhibited the decrease in stiffness when tested neat.

Rebecca McDaniel – Unfortunately had little experience on FSCH testing of aged samples, especially at elevated temperatures. She graciously arranged further discussions with Terhi Pellinen.

Terhi Pellinen – After reviewing a summary of the data was convinced that the material stiffness does soften due to the aging. However, she believes that it is more due to the development of micro-cracks within the HMA, than actual softening. The FSCH is conducted at low shear strains (0.01%), which for a 50 mm thick sample correlates to 0.005 mm of shear deformation. What may be occurring is that a portion of the 0.005 mm is actually taken up by the closing of the micro-cracks. Therefore, less stress is needed to deform the sample 0.01% which results in a lower G*. As opposed to the SSCH and RSCH, which when compared to the FSCH, are larger strain tests, although both are conducted in a stress-controlled environment. The SSCH, when tested at 40C, may achieve maximum shear strains of 0.1 to 0.6%, which relates to 0.05 to 0.3 mm in deformation, over 10 times larger than the FSCH.

This larger strain may overcome the influence of the micro-crack.

Further answers are being sought.

2. Proposed activities for next quarter by task:

- A. All testing has been completed, as well as the statistical analysis. The report is being finalized and will be given to a proof reader to correct grammar and structure.

3. List of deliverables provided in this quarter by task (product date)

N.A.

4. Progress on Implementation and Training Activities

N.A.

5. Problems/Proposed Solutions

N.A.

6. Budget Summary*

Total Project Budget(# of years)	3 Years	\$213,544.00
Total Project Expenditure to date		\$212,765
% of Total Project Budget Expended		100%
Task Order Number/Study Number:		80 / 4-23908
Current Task Order Budget (# of years)	Years 1, 2, and 3	\$213,544.00
Actual Expenditure to date against current task order		\$212,765
% of current task order budget expended		100%

* These are approximate expended amounts for the project; these estimates are for reference only and should not be used for official accounting purposes. For a more accurate project accounting please review the quarterly invoice for this project.